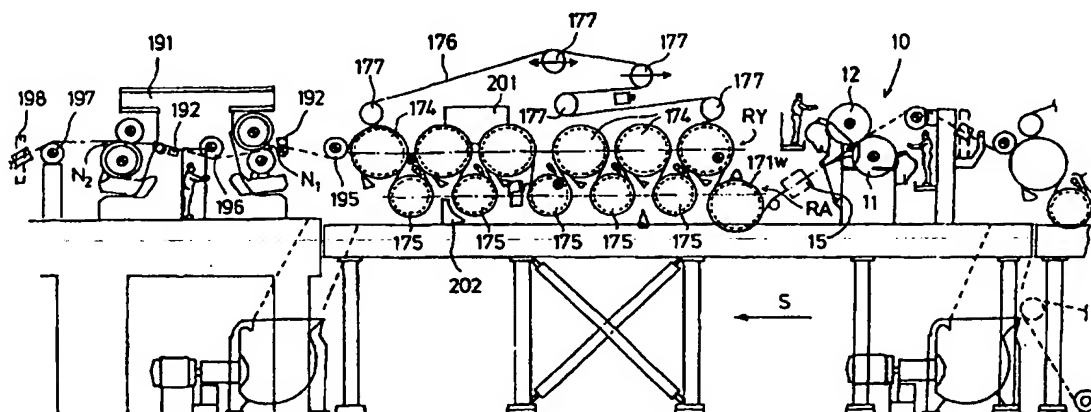




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<b>(21) International Application Number:</b> PCT/FI97/00531 <b>(22) International Filing Date:</b> 9 September 1997 (09.09.97) <b>(30) Priority Data:</b> 963734 20 September 1996 (20.09.96) FI <b>(71) Applicant (for all designated States except US):</b> VALMET CORPORATION [FI/FI]; Panuntie 6, FIN-00620 Helsinki (FI). <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> ÖSTMAN, Kauko, Antero [FI/FI]; Vaskontie 14, FIN-40520 Jyväskylä (FI). <b>(74) Agent:</b> FORSSÉN & SALOMAA OY; Yrjönkatu 30, FIN-00100 Helsinki (FI).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> With international search report. With amended claims.

**(54) Title:** METHOD FOR DRYING A SURFACE-TREATED PAPER WEB OR EQUIVALENT IN AN AFTER-DRYER OF A PAPER MACHINE AND AFTER-DRYER CARRYING OUT THE METHOD IN A PAPER MACHINE

**(57) Abstract**

The invention concerns a method for drying a surface-treated paper web or equivalent in an after-dryer of a paper machine, in which method the paper web (W) is first finished in a finishing section, in which finishing section the paper web (W) is surface-sized or coated by means of a finishing device (10), after which the paper web (W) is dried. In the after-dryer the paper web (W) is dried in a dryer group/groups making use of a normal single-wire draw, and, in connection with or after the drying, the paper web (W) is treated by means of a device/devices (192, 191, 201, 202) in order to compensate for a tendency of curling of the paper web (W). Further, the invention concerns an after-dryer for a paper machine for applying the method to the drying of a surface-treated paper web or equivalent, which after-dryer is placed after the finishing device (10), by means of which finishing device (10) the paper web (W) is surface-sized or coated. The after-dryer comprises at least one dryer group that applies a normal single-wire draw so as to dry the paper web (W) and a device/devices (191, 192, 201, 202) for compensating for a tendency of curling of the paper web (W).

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Method for drying a surface-treated paper web or equivalent  
in an after-dryer of a paper machine and after-dryer  
carrying out the method in a paper machine

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The invention concerns a method for drying a surface-treated paper web or equivalent in an after-dryer of a paper machine, in which method the paper web is first  
10 finished in a finishing section, in which finishing section the paper web is surface-sized or coated by means of a finishing device, after which the paper web is dried.

The invention also concerns an after-dryer for a paper machine for applying the method in accordance with the present invention to the drying of a surface-treated  
15 paper web or equivalent, which after-dryer is placed after the finishing device, by means of which finishing device the paper web is surface-sized or coated.

As is known from the prior art, in multi-cylinder dryers of paper machines, twin-wire draw and/or single-wire draw is/are employed. In twin-wire draw the groups  
20 of drying cylinders comprise two wires, which press the web one from above and the other one from below against heated cylinder faces. Between the rows of drying cylinders, which are usually horizontal rows, the web has free and unsupported draws, which are susceptible of fluttering, which may cause web breaks, in particular so when the web is still relatively moist and, therefore, of low strength. This is  
25 why, in recent years, ever increasing use has been made of said single-wire draw, in which each group of drying cylinders includes just one drying wire, on whose support the web runs through the whole group so that the drying wire presses the web on the drying cylinders against the heated cylinder faces, whereas on the reversing cylinders or rolls between the drying cylinders the web remains at the side  
30 of the outside curve. Thus, in single-wire draw, the drying cylinders are placed outside the wire loop, and the reversing cylinders or rolls inside said loop.

In the what is called normal groups with single-wire draw, known from the prior art, the heated drying cylinders are placed in the upper row and the reversing cylinders are placed in the lower row, which rows are, as a rule, horizontal and parallel to one another. On the other hand, in inverted groups with single-wire draw, the reversing cylinders are placed in the upper row and the drying cylinders in the lower row. In the following, when the terms "normal (dryer) group" and "inverted (dryer) group" are used, what is meant is expressly groups with single-wire draw in multi-cylinder dryers, of the sort mentioned above.

10 When paper is dried by means of normal groups with single-wire draw from the side of its bottom face and if such asymmetric drying is extended over the entire length of the forward dryer section, the drying takes place so that first the bottom-face side of the paper web is dried and, when the drying makes progress, the drying effect is also extended to the side of the top face of the paper web. Under these circum-  
15 stances, the dried paper is usually curled and becomes concave, seen from above.

As is known from the prior art, the tendency of curling of paper is already affected in connection with the web formation, in particular at the sheet formation stage by means of selection of the difference in speed between the slice jet and the wire, and  
20 by means of other running parameters. As is known from the prior art, for example, in the case of copying paper, by means of unequalsidedness of drying in the after-dryer a suitable initial curl form is regulated for the sheet in order that the curling of the paper after one-sided or double-sided copying could be optimized. In the case of copying paper, the reactivity of curling, i.e. the extent to which curling occurs  
25 per unit of change in moisture content, is affected to a greater extent by means of a multi-layer structure of the paper, which is produced in connection with the web formation in the wet end.

The most recent technology related to the present invention in high-speed paper  
30 machines, in particular in fine-paper machines, has been based on dryer sections in which there is single-wire draw over the major part of the length of the machine, and, in view of controlling the tendency of curling of paper, in practice, an inverted

group has also been used in order that the drying could be made sufficiently symmetric in the z-direction.

5 In conventional after-dryers in paper machines, in which the web is dried after coating or surface-sizing, a problem has been the swelling of the web arising from the moisture introduced by the coating into the web, which swelling produces "wrinkles" and equivalent problems that deteriorate the runnability in the web. In twin-wire draw, which is used traditionally in an after-dryer, the web flutters between the upper and lower rows, in which connection web breaks tend to occur  
10 and, moreover, on the drying cylinders in the lower row, when the web is wrinkled, the drying wire of the lower row has been readily damaged as a result of the wrinkles, the problem consisting of frequent replacements of the lower fabric.

Further, as is known from the prior art, problems have also been caused by the  
15 lowering of the web strength resulting from the coating, in which connection long free draws of the web have been quite problematic.

From the prior art, solutions are known for an after-dryer for paper to be coated, in particular for fine paper or equivalent, in which dryer there is first an upper cylinder  
20 and a lower cylinder and after this one group that employs normal single-wire draw, and after that dryer groups that make use of twin-wire draw. In these applications, it is a problem that, in view of the tendency of curling of paper, the ratio of the upper and lower cylinders is wrong if the curling is supposed to be regulated efficiently. As is known from the prior art, in the after-dryer it has been necessary  
25 to keep the temperature of the first cylinders low because of adhering of the web and the size/paste to the cylinder.

Groups of the sort mentioned above for finishing of paper to be coated, in particular of fine paper, have been described, among other things, in the applicant's *FI Patent Application No. 950434*. Thus, the object of the present invention is further develop-  
30 ment of the solutions suggested in said application so that the tendency of curling of paper can be controlled more efficiently in the after-dryer.

It is a further object of the invention to provide such a solution for an after-dryer as is suitable for use in particular in dryer sections in which it has not been possible or desirable to control the curling of the paper web in the forward dryer.

- 5 Also, it is an object of the invention to create an arrangement in which there are no long free draws while the web is still moist after the coating.

It is a further object of the present invention to provide such an after-dryer for a paper machine in which the runnability can be brought to a particularly high level.

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Further, it is an additional object of the invention to provide such an after-dryer for a paper machine in which a what is called ropeless threading can be applied favourably within the entire length of the after-dryer in the machine direction, which for its part contributes to making the constructions simpler and standstills shorter.

15

In view of achieving the objectives stated above and those that will come out later, the method in accordance with the invention is mainly characterized in that in the after-dryer the paper web is dried in a dryer group/groups making use of a normal single-wire draw, and that, in connection with or after the drying, the paper web is  
20 treated by means of a device/devices in order to compensate for a tendency of curling of the paper web.

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Further, the after-dryer that makes use of the method of the present invention is mainly characterized in that the after-dryer comprises at least one dryer group that applies a normal single-wire draw so as to dry the paper web and a device/devices for compensating for a tendency of curling of the paper web.

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In the arrangement in accordance with the invention, in which the whole after-dryer is formed as a group with single-wire draw or is composed of a group with single-wire draw, the web is supported over the entire length of the dryer section, in which case the runnability is very good. Possible curling of the web is compensated for, for example, by means of steam boxes and/or by means of soft-calendering. The web

can also be passed to an upper cylinder directly after the coating, in which case the draw is closed right from the beginning of the after-dryer over the entire length of the after-dryer.

- 5 In the following the invention will be described in more detail with reference to the figures in the accompanying drawing, the invention being, however, in no way supposed to be strictly confined to the details of said illustrations.

Figure 1 is a schematic illustration of an exemplifying embodiment of an after-dryer,  
10 which is composed of a dryer group that applies a normal single-wire draw, and

Figure 2 is a schematic illustration of an arrangement in which, after the coating, the web is passed directly onto the upper cylinder in the group with single-wire draw over a reversing blow-box or a reversing roll or equivalent, in which case a closed  
15 draw is obtained over the entire length.

In Fig. 1 the coating device is denoted with the reference numeral 10, and the coating device 10 is, for example, a coating device marketed by the applicant with the name SYM-SIZER™, which device comprises two opposite coating rolls 11 and  
20 12, in connection with each of which there are size feed devices so that the paper web W is coated from both sides in the coating nip between the rolls 11 and 12. The direction of progress of the paper web W is denoted with the reference arrow S. After the coating device 10 the web W is passed over the drying cylinder 171 into the dryer group that applies a normal single-wire draw, in which group the reversing  
25 rolls/cylinders, fitted inside the drying-wire loop 176 guided by the guide rolls 177, are denoted with the reference numeral 175 and the drying cylinders are denoted with the reference numeral 174. In the dryer group the paper web W to be dried runs from the drying cylinders 174 placed in the upper row RY onto the reversing  
rolls 175 placed in the lower row RA so that on the drying cylinders 174 the web W  
30 is placed against the heated face of the drying cylinder 174, and on the reversing rolls 175 placed in the lower row RA the web W remains at the side of the outside curve on the wire 176. After the dryer group the paper web W is passed over the

guide roll 195 to the soft calender 191, which comprises two calender nips N1 and N2. In connection with the soft calender, two steam boxes 192 are also placed, and curling of the paper web W is compensated for by means of the soft-calendering and by means of the steam boxes. Over the guide roll 197 the paper web is passed  
5 through the nip device 198 to further processing. Between the calendering nips N1,N2 the web is guided over the guide roll 196.

In Fig. 1, after the coating device 10, a pre-drying unit 15 is fitted, which does not contact the web W and which can be an infrared dryer or an airborne web dryer or  
10 a combination of same, in itself known from the prior art. In the final portion of the after-dryer, a blower unit 201 is fitted, by whose means attempts are made to promote evaporation through the wire, i.e. to equalize the distribution of moisture in the direction of thickness in the paper that departs from the after-dryer. Further, in the arrangement, there may be a steam box 202 in itself known, of the sort  
15 described, for example, in the *FI Patent Application No. 906216*, or a moistening device 202, which is also in itself known, by means of which devices 202 the distribution of moisture in the Z-direction of the web is equalized and/or the curling of the web is reduced. All of these additional devices are, of course, not necessarily in use in the same construction.

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In relation to curling of the paper web, the applicant has carried out tests with a newsprint machine, whose dryer section was exclusively provided with single-wire draw and which dryer section was followed by a two-nip soft calender preceded by a steam box. In these reference test run conditions, it was noticed that the web was  
25 curled in the direction of the top face - the edges of a sample of a diameter of 100 mm rose 3 centimetres in the direction of the top face. When the running conditions were kept in the other respects unchanged but the bottom face of the web was steam-treated before the latter soft-calender nip, the curling was reduced significantly to the value 1.2 cm. In a second test the dryer section was run normally, in which case the  
30 curling was measured as 1.5...2 cm, and when the bottom face of the web was steam-treated in the way mentioned above, the web was no longer curled at all.



As regards its principal features, the exemplifying embodiment shown in Fig. 2 is similar to the exemplifying embodiment shown in Fig. 1, but in the embodiment of Fig. 2, after the coating device, a reversing blower device 14 is fitted, by whose means the web is turned so that it is passed directly onto the drying cylinder 174 in the upper row. After this, there follow two dryer groups that apply a normal single-wire draw, and between said groups there is a closed draw. The parts in the first dryer group that applies a normal single-wire draw are denoted with the reference denotations corresponding to Fig. 1, and the drying cylinders in the second dryer group are denoted with the reference numeral 182 and the reversing rolls/cylinders with the reference numeral 181. The drying wire 186 in the second dryer group runs guided by the guide rolls 187. After the dryer groups, after the guide roll 184, the dried paper web W is passed, in compliance with what is shown in Fig. 1, to the soft calender 191, in whose connection preferably also steam boxes 192 are fitted, in which case it is possible to control the curling of the web W by means of the steam boxes 193 and by regulating the calendering nips N1,N2 of the soft calender 191 in a suitable way.

In the arrangement in accordance with the invention, as the reversing rolls/cylinders, particularly favourably are used the suction cylinders marketed by the applicant with the trade mark "VAC-ROLL"™ and provided with no inside suction box, reference being made, with respect to the details of the constructions of said rolls, to the applicant's *FI Patent No. 83,680 (equivalent US Patents Nos. 5,022,163 and 5,172,491)*.

Above, the invention has been described just with reference to some preferred exemplifying embodiments of same only, the invention being, however, by no means supposed to be strictly confined to the details of said embodiments.

## Claims

1. A method for drying a surface-treated paper web or equivalent in an after-dryer of a paper machine, in which method the paper web (W) is first finished in a finishing section, in which finishing section the paper web (W) is surface-sized or coated by means of a finishing device (10), after which the paper web (W) is dried, **characterized** in that in the after-dryer the paper web (W) is dried in a dryer group/groups making use of a normal single-wire draw, and that, in connection with or after the drying, the paper web (W) is treated by means of a device/devices (192, 191,201,202) in order to compensate for a tendency of curling of the paper web (W).
2. A method as claimed in claim 1, **characterized** in that in the after-dryer the paper web (W) is dried in a dryer group/groups that make(s) use of a normal single-wire draw, and that, after drying, the paper web (W) is guided past at least one steam box (192) and/or through at least one soft-calender nip (N1;N2) so as to compensate for a tendency of curling of the paper web (W).
3. A method as claimed in claim 1 or 2, **characterized** in that in the after-dryer the paper web is dried in a dryer group/groups that make(s) use of a normal single-wire draw, and that, after drying, the paper web is guided past at least one blower unit (201), by whose means evaporation through the wire is promoted in view of equalizing the distribution of moisture in the direction of thickness in the web (W) that departs from the after-dryer.
4. A method as claimed in any of the claims 1 to 3, **characterized** in that in the after-dryer the paper web is dried in a dryer group/groups that make(s) use of a normal single-wire draw, and that the paper web (W) is guided past a steam box and/or a moistening device (202) so as to equalize the distribution of moisture in the Z-direction in the web and/or to reduce the curling of the web (W).

5. A method as claimed in any of the preceding claims 1 to 4, **characterized** in that in the after-dryer the paper web is dried in the initial part of the after-dryer, before the dryer group/groups that make(s) use of single-wire draw, by means of a contact-free pre-dryer section (15).

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6. A method as claimed in claims 1 to 5, **characterized** in that after the paper-web (W) finishing device (10) the paper web (W) is guided over a drying cylinder (171) into a dryer group/groups that make(s) use of single-wire draw, and that after said dryer group the paper web (W) is guided past a steam box (192), by whose means  
10 curling of the paper web (W) is compensated for, into a soft calender (191), in which the paper web (W) is calendered in two successive calendering nips (N1,N2), between which the curling of the paper web (W) is compensated for by means of a steam box (192).

15 7. A method as claimed in any of the claims 1 to 6, **characterized** in that in the method the paper web (W) is dried in one dryer group that makes use of single-wire draw (FIG. 1).

20 8. A method as claimed in any of the claims 1 to 6, **characterized** in that in the method the paper web (W) is dried in two dryer groups that make use of single-wire draw (FIG. 2).

25 9. A method as claimed in any of the claims 1 to 8, **characterized** in that after the finishing device (10) the paper web (W) is passed over a reversing blow device (14) into a dryer group that makes use of single-wire draw.

10. A method as claimed in any of the claims 1 to 8, **characterized** in that after the finishing device (10) the paper web (W) is passed over a drying cylinder (171) placed in the lower row (RA) into a dryer group that makes use of single-wire draw.

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11. A method as claimed in any of the claims 1 to 9, **characterized** in that in the method, after the finishing device (10), the paper web (W) is passed as a closed

draw onto the first drying cylinder in the upper row (RY) in a dryer group that makes use of a normal single-wire draw.

5 12. A method as claimed in any of the preceding claims, **characterized** in that in the method the paper web (W) is passed from one dryer group into the other as a closed draw.

10 13. An after-dryer for a paper machine for applying the method as claimed in any of the claims 1 to 12 to the drying of a surface-treated paper web or equivalent, which after-dryer is placed after the finishing device (10), by means of which finishing device (10) the paper web (W) is surface-sized or coated, **characterized** in that the after-dryer comprises at least one dryer group that applies a normal single-wire draw so as to dry the paper web (W) and a device/devices (191,192,201, 202) for compensating for a tendency of curling of the paper web (W).

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14. An after-dryer as claimed in claim 13, **characterized** in that after the dryer group/groups that applies/apply single-wire draw a soft calender (191) and/or steam boxes (192) are fitted so as to compensate for a curling tendency of the paper web.

20 15. An after-dryer as claimed in claim 13 or 14, **characterized** in that in the final portion of the after-dryer a blower unit (201) is fitted so as to promote evaporation taking place through the wire and to equalize the distribution of moisture in the direction of thickness in the paper web (W) that departs from the after-dryer.

25 16. An after-dryer as claimed in any of the claims 13 to 15, **characterized** in that in the after-dryer a steam box and/or a moistening device (202) are fitted so as to equalize the distribution of moisture in the Z-direction in the paper web (W) and/or to reduce the curling of the paper web (W).

30 17. An after-dryer as claimed in any of the claims 13 to 16, **characterized** in that, in the beginning of the after-dryer, before the dryer group/groups using single-wire draw, a pre-dryer (15) is fitted for contact-free pre-drying of the paper web.

18. An after-dryer as claimed in any of the claims 13 to 17, **characterized** in that the after-dryer comprises one dryer group that makes use of single-wire draw and that is placed after the finishing device (10).
- 5 19. An after-dryer as claimed in any of the claims 13 to 17, **characterized** in that the after-dryer comprises two dryer groups that make use of single-wire draw and that are placed after the finishing device (10).
20. An after-dryer as claimed in any of the claims 13 to 19, **characterized** in that  
10 two steam boxes (192) are fitted after the dryer group/groups.
21. An after-dryer as claimed in claim 20, **characterized** in that a steam box (192) is fitted before a calendering nip (N1;N2) of the soft calender (191).
- 15 22. An after-dryer as claimed in any of the claims 13 to 21, **characterized** in that after the finishing device (10) a reversing blow device (14) is fitted before a dryer group that makes use of single-wire draw.
23. An after-dryer as claimed in any of the claims 13 to 22, **characterized** in that  
20 between the dryer groups in the after-dryer the paper web (W) has a closed draw.

**AMENDED CLAIMS**

[received by the International Bureau on 3 February 1998 (03.02.98);  
original claims 1 and 13 amended; remaining  
claims unchanged (4 pages).]

1. A method for drying a surface-treated paper web or equivalent in an after-dryer of a paper machine, in which method the paper web (W) is first finished in a finishing section, in which finishing section the paper web (W) is surface-sized or coated on both sides by means of a finishing device (10), after which the paper web (W) is dried, **characterized** in that in the after-dryer the paper web (W) is dried in a dryer group/groups making use only of a normal single-wire draw, and that, in connection with or after the drying, the paper web (W) is treated by means of a device/devices (192, 191,201,202) in order to compensate for a tendency of curling of the paper web (W).
2. A method as claimed in claim 1, **characterized** in that in the after-dryer the paper web (W) is dried in a dryer group/groups that make(s) use of a normal single-wire draw, and that, after drying, the paper web (W) is guided past at least one steam box (192) and/or through at least one soft-calender nip (N1;N2) so as to compensate for a tendency of curling of the paper web (W).
3. A method as claimed in claim 1 or 2, **characterized** in that in the after-dryer the paper web is dried in a dryer group/groups that make(s) use of a normal single-wire draw, and that, after drying, the paper web is guided past at least one blower unit (201), by whose means evaporation through the wire is promoted in view of equalizing the distribution of moisture in the direction of thickness in the web (W) that departs from the after-dryer.
4. A method as claimed in any of the claims 1 to 3, **characterized** in that in the after-dryer the paper web is dried in a dryer group/groups that make(s) use of a normal single-wire draw, and that the paper web (W) is guided past a steam box and/or a moistening device (202) so as to equalize the distribution of moisture in the Z-direction in the web and/or to reduce the curling of the web (W).

5. A method as claimed in any of the preceding claims 1 to 4, **characterized** in that in the after-dryer the paper web is dried in the initial part of the after-dryer, before the dryer group/groups that make(s) use of single-wire draw, by means of a contact-free pre-dryer section (15).

5

6. A method as claimed in claims 1 to 5, **characterized** in that after the paper-web (W) finishing device (10) the paper web (W) is guided over a drying cylinder (171) into a dryer group/groups that make(s) use of single-wire draw, and that after said dryer group the paper web (W) is guided past a steam box (192), by whose means curling of the paper web (W) is compensated for, into a soft calender (191), in which the paper web (W) is calendered in two successive calendering nips (N1,N2), between which the curling of the paper web (W) is compensated for by means of a steam box (192).

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7. A method as claimed in any of the claims 1 to 6, **characterized** in that in the method the paper web (W) is dried in one dryer group that makes use of single-wire draw (FIG. 1).

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8. A method as claimed in any of the claims 1 to 6, **characterized** in that in the method the paper web (W) is dried in two dryer groups that make use of single-wire draw (FIG. 2).

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9. A method as claimed in any of the claims 1 to 8, **characterized** in that after the finishing device (10) the paper web (W) is passed over a reversing blow device (14) into a dryer group that makes use of single-wire draw.

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10. A method as claimed in any of the claims 1 to 8, **characterized** in that after the finishing device (10) the paper web (W) is passed over a drying cylinder (171) placed in the lower row (RA) into a dryer group that makes use of single-wire draw.

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11. A method as claimed in any of the claims 1 to 9, **characterized** in that in the method, after the finishing device (10), the paper web (W) is passed as a closed draw

onto the first drying cylinder in the upper row (RY) in a dryer group that makes use of a normal single-wire draw.

12. A method as claimed in any of the preceding claims, **characterized** in that in the method the paper web (W) is passed from one dryer group into the other as a closed draw.

13. An after-dryer for a paper machine for applying the method as claimed in any of the claims 1 to 12 to the drying of a surface-treated paper web or equivalent, which after-dryer is placed after the finishing device (10), by means of which finishing device (10) the paper web (W) is surface-sized or coated on both sides, **characterized** in that the after-dryer comprises a dryer group/groups applying only a normal single-wire draw so as to dry the paper web (W) and a device/devices (191, 192, 201, 202) for compensating for a tendency of curling of the paper web (W).

14. An after-dryer as claimed in claim 13, **characterized** in that after the dryer group/groups that applies/apply single-wire draw a soft calender (191) and/or steam boxes (192) are fitted so as to compensate for a curling tendency of the paper web.

15. An after-dryer as claimed in claim 13 or 14, **characterized** in that in the final portion of the after-dryer a blower unit (201) is fitted so as to promote evaporation taking place through the wire and to equalize the distribution of moisture in the direction of thickness in the paper web (W) that departs from the after-dryer.

16. An after-dryer as claimed in any of the claims 13 to 15, **characterized** in that in the after-dryer a steam box and/or a moistening device (202) are fitted so as to equalize the distribution of moisture in the Z-direction in the paper web (W) and/or to reduce the curling of the paper web (W).



## 15

17. An after-dryer as claimed in any of the claims 13 to 16, **characterized** in that, in the beginning of the after-dryer, before the dryer group/groups using single-wire draw, a pre-dryer (15) is fitted for contact-free pre-drying of the paper web.

5 18. An after-dryer as claimed in any of the claims 13 to 17, **characterized** in that the after-dryer comprises one dryer group that makes use of single-wire draw and that is placed after the finishing device (10).

10 19. An after-dryer as claimed in any of the claims 13 to 17, **characterized** in that the after-dryer comprises two dryer groups that make use of single-wire draw and that are placed after the finishing device (10).

20. An after-dryer as claimed in any of the claims 13 to 19, **characterized** in that two steam boxes (192) are fitted after the dryer group/groups.

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21. An after-dryer as claimed in claim 20, **characterized** in that a steam box (192) is fitted before a calendering nip (N1;N2) of the soft calender (191).

20 22. An after-dryer as claimed in any of the claims 13 to 21, **characterized** in that after the finishing device (10) a reversing blow device (14) is fitted before a dryer group that makes use of single-wire draw.

23. An after-dryer as claimed in any of the claims 13 to 22, **characterized** in that between the dryer groups in the after-dryer the paper web (W) has a closed draw.

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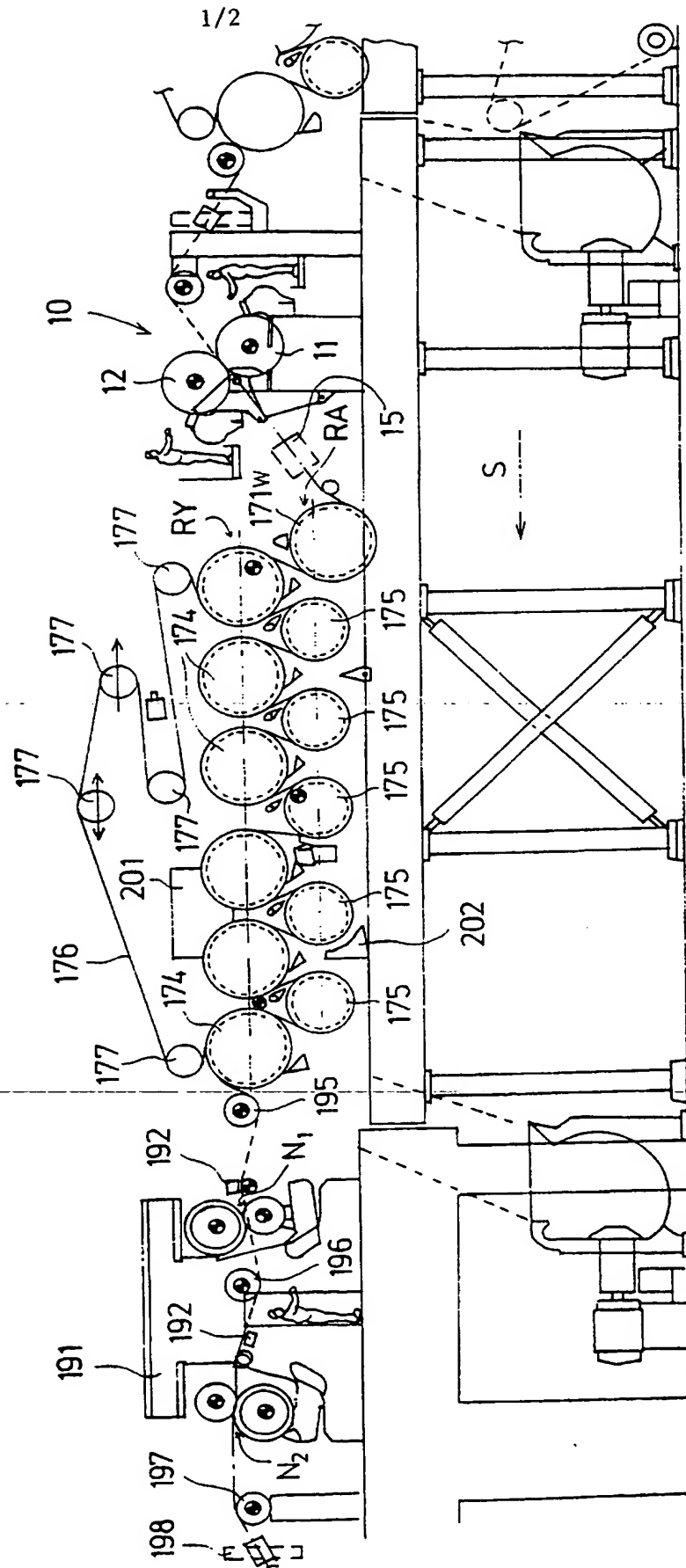


FIG. 1

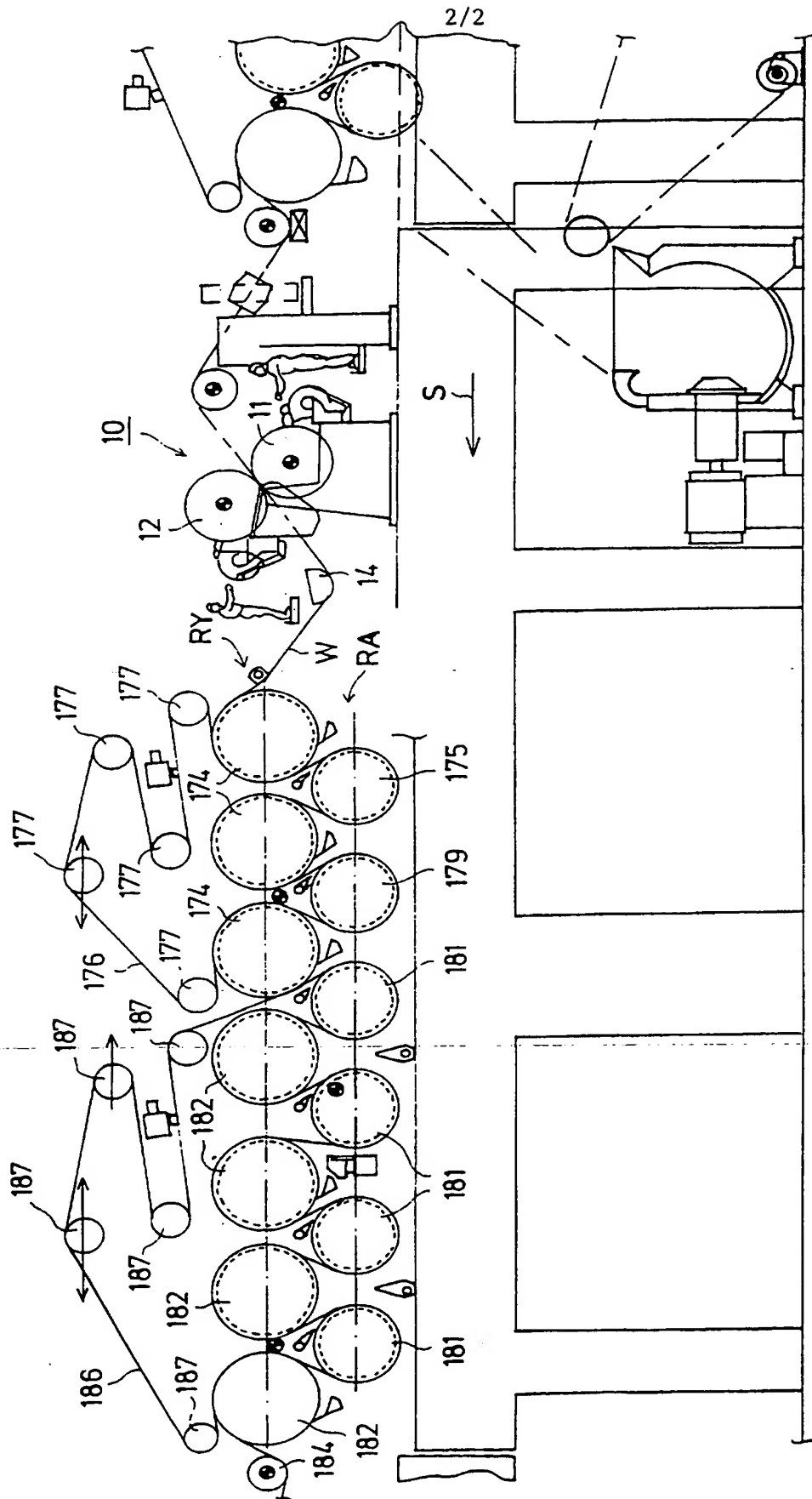


FIG.2

1  
**INTERNATIONAL SEARCH REPORT**

International application No.  
**PCT/FI 97/00531**

**A. CLASSIFICATION OF SUBJECT MATTER**

**IPC6: D21F 5/04**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

**IPC6: D21F**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

**SE,DK,FI,NO classes as above**

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**WPI**

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
<b>X</b>	<b>EP 0726353 A2 (VALMET CORPORATION), 14 August 1996 (14.08.96), abstract, column 16, line 44 - line 49, column 17, line 39 - line 44, column 20, line 31 - line 38, line 45 - line 53, column 21, line 8 - line 15 figure 1,3,4,9-11A</b>  -----	<b>1-23</b>

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

\* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
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\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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\*&\* document member of the same patent family

Date of the actual completion of the international search

**31 October 1997**

Date of mailing of the international search report

**03-12-1997**

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

01/10/97

International application No.

PCT/FI 97/00531

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		FI 950434 A,V	02/08/96
		JP 8311793 A	26/11/96
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